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Efficiency Analysis of Turkish Preparation and Spinning of Textile Fibres; Weaving of Textiles Industry: The Cases of Firm-Based and Cumulative Data

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Abstract

This study has been intended to obtain the efficiency scores of the sector coded Preparation and Spinning of Textile Fibers, Weaving of Textiles Industry in Turkish Manufacturing Industry by aggregating the firm-based and cumulative data of the 484 firms in 38 cities. Then the similar and different qualities of the results obtained in either case have been discussed in the study. Data Envelopment Analysis has been used for the efficiency analyses. This study is a pilot research concerning a larger one with a higher budget.

Key words: *Efficiency, textiles, DEA*

1. Introduction

Analyses of the efficiency, a significant criteria of performance measurement, have been usually realized, depending on sectoral (2, 3 and 4 –digit) and regional (city, region and country) aggregate. This is mainly because the data sets can be published in a aggregate way. In other words, the institutes that compile such data, i.e. Turkish Statistical Institute (TURKSTAT), assure the firms that such data will not be published as firm-based. Therefore, the efficiency analyses realized with the use of the data aggregated by various institutes can be carried out by using the aggregated data all over the world. One of the reasons why such studies have not been made so far is that researchers have failed to aggregate such a lot of firm-based data and have just recently been afforded the chance by TURKSTAT to make use of such data. Therefore, firm-based efficiency research based on a large set of data has not been done adequately. To make research by using cumulative and firm-based data is important from some aspects. The advantage of using the cumulative data is that they give the results regarding the measurement of performance on the level of collection because of the fact that the effect of the units on the level of collection with a higher weight is observed better and more clearly. However, the differences between the decision units cannot be determined exactly since the number of decision units is smaller in the analyses made with aggregated data and the efficiency

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analyses involve the comparison of the decision units. In other words, efficiency scores become higher and standard deviation of the efficiency scores of decision units becomes lower.

Firm-based analyses contain the performance results of each firm. Yet it is not possible to make an evaluation of the mean results because firm-based results of the ones obtained from such data cannot be published and it is not possible to get information in any way whatsoever. Furthermore, since any average score obtained in this way takes each firm as a single unit, the effect on the average of the firms with a higher share in the sector and geographic unit is taken as the same as that of the with a lower share. For this reason, it may cause deviant data to be produced in comparison with the real case.

Given all the above issues, one of the purposes of the present study is to arrive at general rules by determining the differences between the efficiency scores calculated with an eye to the aggregated and firm-based and cumulative data and then the causes of these differences. Yet there is just one thing that this study does not maintain, which is that the results from firm-based data are accurate and have no deviation, while the ones from cumulative data are wrong and have deviation.

In this study, just the sector defined by 1711 in[1] the ISIC revised-3 data classification system has been analyzed. The reason for this is associated with the purpose of the study. As cumulative and firm-based data will be compared in the study, only a sector has been used so that these results will not be affected by the qualities of different sectors, namely so that they can be analyzed in the most homogenous possible way. Another reason is that it is a pilot project study[2]. Data Envelope Analysis has been used for the efficiency analyses in the study.

2. Data

Data set has been obtained from "Industrial Analysis Data Store, 2006" of Turkish Statistical Institute (TURKSTAT). This database contains the firms employing more than 9 workers. The study has been designed to analyze 750 firms employing more than 9 workers in the sector coded 1711 within the ISIC revised-3 data classification system.

[1] Preparation and spinning of textile fibers; weaving of textiles

[2] It is second step of the three step study. In the first step it is planned a pilot study. The results of the first step, which is supported by the Denizli SMSs Eurpian Information Office can be seen in Yesilyurt (2007) study. In the first step firm based efficiency analysis applied to Denizli and its periphery. In this step 1711 coded sector, the most information sector for Denizli, examined. In the last step stochastic frontier analysis will be used and the analysis will be expanded to all sectors and we will give weights to efficiency scores which will make firm based data results more confident.

However, some of them have been omitted from the analysis since they do not exist in the data set of some years and have deficits in their data. As a result, 484 firms have been included in the study. As 24 of them are within the scope of secrecy, however, the results belonging to these 24 firms have been excluded from the study. It may be more significant and meaningful to detail this case. The firms contained in the study are located in 38 cities. Accordingly, each of 38 cities has been taken as a different decision unit while making analysis with cumulative data. It has also been impossible to publish any results for the cities of Amasya, Bilecik, Erzincan, Kütahya, Nevşehir, Tokat, Şanlıurfa, Karaman, Osmaniye and Diyarbakır, Edirne, Kocaeli, Konya, Niğde, Ordu and Yalova as there are two firms in the last seven cities while there is just one in the first nine. The results concerning firm-based analyses have been present within this scope. The study, then, involves the years from 1998 to 2001. Indeed, however, the existing database includes the years prior to 1998, as well. When this database is examined, it appears that the rate of firm's continuity is around 75-80%. In other words, when a period is taken, approximately 20-25% of the firms that were present in the first year do not appear in the four-year database, a result that means that the rate of firm's continuity is around 75-80%. As this study is intended as a panel, the study has been limited to four years so that the number of the firms is not reduced to a level in which the study cannot be made. If the period is kept longer, then number of the firms that stand in all years will be smaller. As this case may also reduce the number of the firms existing in some cities to smaller than 3, those cities might also be omitted from the study. This case, then, may pose a more serious problem as it will cause fewer decision units to be included in the analysis.

Table 1 gives the descriptive results for inputs of each year, i.e. the raw material, labour (workers' working hours) capital, (horse power capacity) and outputs.

Table 1: Descriptive statistics

Year	Stats	Output	Law materials	Labour	Horse power
1998	Mean	41,111,774,488	31,710,917,012	458,909	2,153
	S.D	81,460,012,085	67,029,487,493	842,947	5,894
1999	Mean	38,294,591,040	28,696,569,859	451,030	2,164
	S.D	113,000,000,452	82,093,319,839	819,898	6,620
2000	Mean	44,149,169,575	31,877,089,936	436,676	2,241
	S.D	118,087,495,248	84,245,748,776	799,133	6,901
2001	Mean	46,193,770,727	35,354,310,905	439,561	2,146
	S.D	143,043,362,076	106,762,517,391	865,277	6,450

3. Methodology: Data Envelopment Analysis

Charnes et al. (CCR) (1981) conducted the reference study that constitutes the starting point of DEA, the method used in the present study. The following are some of the important studies that have contributed to the development of DEA: Forsund and Sarafoglu (2000); Ahn et al. (1988); Thrall (1989); Charnes et al. (1981), Banker (1993), Banker and Maindiratta (1986), Banker et al. (1986), Bogetoft (1996), Cook (1993), Banker and Maindiratta (1988), Banker et al. (1984), Tambour (1997) and Siddhartan et al.(1999). VRS measurement of DEA provides proper solutions regarding the real life. VRS measurement has been taken into consideration in this study, too.

Each firm in N number has been assumed to have K input and M output, and the input and output column vectors for the i^{th} firm have also been assumed to be represented by x_i and y_i. Then K*N input matrix has been described as X and M*N output matrix as Y, which is the case for all the firms. As the rate of all outputs is due to be measured with all the incomes as in $u'y_i/v'x_i$, in this formulation 'u' is the vector of M*1 output weights and 'v' is that of K*1 income weights. On the other hand, optimal weighting has been obtained by solving the following mathematical programming problem:

$$\max_{uy}\left(u'y_i \,/\, v'x_i\right),$$

$$\text{s.t.} \quad u'y_i \,/ v'x_i \le 1, \qquad i = 1,2,...N$$

$$u, v \ge 0 \qquad (1)$$

The efficiency measurement containing u and v values for the i^{th} firm has been maximized under the limit that these values should be equal to or lower than 1. Infinite is the number of problem solutions in this formulation. If limit v' x_j=1 is added to the 1st solution for the purpose of avoiding this case and then it is rearranged, it becomes possible to obtain the following problem:

$$\max_{\mu.v}(\mu'y_i),$$

$$\text{s.t} \quad v'x_i = 1,$$

$$\mu'y_i - v'x_j \le 0, \qquad i = 1,2,...N$$

$$\mu, v \ge 0, \qquad (2)$$

To emphasize the different linear programming problem here, u and v notations have been modified to be μ, ν. The equality form in (2) is the multiplying form of the DEA linear

programming problem. Therefore, the CRS linear programming problem can be converted by adding the $N1'\lambda = 1$ convex limit to the VRS linear programming problem and is defined as follows:

$$\min_{\theta.\lambda} \ \theta,$$

$$\text{s.t} \quad -y_i + Y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0,$$
$$N1'\lambda = 1$$
$$\lambda \geq 0$$

4. Results of the Analysis

The results from the analyses have been summarized in Table 2. Efficiency score obtained from the cumulative data of each city takes place in the first line of the cities; in the second line, however, is the average of the efficiency scores obtained from firm-based analysis; the third line gives the firm having the smallest efficiency score, and the fourth line shows the firms with the highest efficiency score. Full efficient ones and the number of the full efficient firms are indicated by the 1* number of firms.

The cities that have the highest number of firms in the sector coded 1711 are Bursa, Denizli, İstanbul and Gaziantep, respectively. The cities with the highest full efficient level are Bursa and Denizli. The fewest firms are, however, in Ankara, Kırklareli, Kastamonu and Muğla. The scores obtained from the cumulative data have proved to have less deviation as they are worked upon with fewer decision units. Firm-based data, however, have turned out to have a higher standard deviation as the differences between the firms have been determined better. Another reason not associated with DEA why the results obtained from cumulative data are like that is the economic factor. In other words, some of the firms in a city may have misused the labour, some the capital and some the raw material. Considering them all as a whole, there may arise the probability that a optimal combination of factors of production close to optimum can be reached. Therefore, high efficiency scores may have been obtained. These are the results anticipated by the authors, albeit interesting. There are also some common results in the relationships between the results from cumulative data and the average results from firm-based data. First of all, efficiency scores obtained from cumulative data in the cities with a small number of firms have been found as high because of the abovementioned reasons, while the results from the firm-based data are low.

In the cities where there are a lot of firms, the firms with low efficiency have pulled down the average level of the city as each firm has been taken as a different decision unit. This case is especially apparent in Bursa and Denizli. For example, the output of 6 of the firms with the highest efficiency level, which take place in %20 of the firms, is much more than half the firms with a low efficiency level. As each firm has been taken as a different decision unit, however, this leads to an impression that efficiency level of the city is low. The same is true to Denizli, as well.

Table 2: Efficiency levels

Province		Years				Firm number
		1998	1999	2000	2001	
Adana	Cumulative mean	0.917	0.815	0.717	0.768	30
	Firm mean	0.538	0.579	0.489	0.490	
	Firm minimum	0.273	0.259	0.173	0.162	
	Firm maximum	1*3	1*4	1*2	1*2	
Ankara	Cumulative mean	1	1	0.736	0.878	3
	Firm mean	0.419	0.492	0.371	0.543	
	Firm minimum	0.321	0.395	0.331	0.467	
	Firm maximum	0.489	0.648	0.431	0.677	
Antalya	Cumulative mean	0.855	0.802	0.821	0.787	6
	Firm mean	0.438	0.631	0.486	0.627	
	Firm minimum	0.287	0.327	0.327	0.428	
	Firm maximum	0.606	0.933	0.710	0.880	
Aydın	Cumulative mean	1	1	0.683	1	15
	Firm mean	0.505	0.712	0.716	0.667	
	Firm minimum	0.246	0.314	0.279	0.474	
	Firm maximum	0.892	0.935	1.000	1*2	
Bursa	Cumulative mean	1	1	1	1	112
	Firm mean	0.483	0.551	0.449	0.460	
	Firm minimum	0.122	0.167	0.023	0.077	
	Firm maximum	1*6	1*6	1*11	1*7	
Denizli	Cumulative mean	1	1	0.949	1	66
	Firm mean	0.537	0.530	0.419	0.414	
	Firm minimum	0.271	0.202	0.209	0.153	
	Firm maximum	1*5	1	1*4	1*3	
Gaziantep	Cumulative mean	0.811	0.927	0.674	0.992	43
	Firm mean	0.553	0.514	0.288	0.452	
	Firm minimum	0.157	0.187	0.168	0.225	
	Firm maximum	1*3	1*3	0.731	1*2	
Hatay	Cumulative mean	0.864	0.873	0.671	1	7
	Firm mean	0.736	0.526	0.562	0.623	
	Firm minimum	0.331	0.260	0.204	0.296	
	Firm maximum	1*2	1.000	1.000	1*2	
Isparta	Cumulative mean	0.972	0.883	0.771	0.797	12
	Firm mean	0.452	0.416	0.333	0.471	
	Firm minimum	0.249	0.185	0.086	0.342	
	Firm maximum	0.704	0.890	0.619	0.652	
İstanbul	Cumulative mean	1	0.937	0.701	1	64
	Firm mean	0.582	0.460	0.439	0.493	
	Firm minimum	0.116	0.179	0.190	0.187	
	Firm maximum	1*8	1*2	1*3	1*2	
İzmir	Cumulative mean	0.89	0.811	0.593	1	23
	Firm mean	0.569	0.547	0.506	0.579	
	Firm minimum	0.153	0.188	0.184	0.134	
	Firm maximum	1*2	1.000		1*4	
Kastamonu	Cumulative mean	1	1	1	1	4
	Firm mean	0.356	0.458	0.363	0.324	
	Firm minimum	0.148	0.131	0.261	0.087	
	Firm maximum	0.488	1.000	0.579	0.595	
Kırklareli	Cumulative mean	0.936	0.988	0.396	0.817	3
	Firm mean	0.690	0.470	0.485	0.467	
	Firm minimum	0.361	0.261	0.221	0.330	
	Firm maximum	1*2	0.881	0.796	0.761	
Malaltya	Cumulative mean	0.605	0.52	0.369	0.736	8
	Firm mean	0.478	0.515	0.426	0.396	
	Firm minimum	0.157	0.283	0.114	0.258	
	Firm maximum	1.000	1.000	1.000	0.550	

Manisa	Cumulative mean	1	0.83	1	1	8
	Firm mean	0.599	0.524	0.643	0.619	
	Firm minimum	0.243	0.334	0.414	0.501	
	Firm maximum	0.614	0.584	0.670	0.661	
K.Maraş	Cumulative mean	0.895	0.878	0.681	0.772	22
	Firm mean	0.408	0.583	0.407	0.426	
	Firm minimum	0.270	0.214	0.165	0.087	
	Firm maximum	0.744	0.860	1.000	1.000	
Muğla	Cumulative mean	1	1	1	1	4
	Firm mean	0.388	0.816	0.732	0.500	
	Firm minimum	0.370	0.568	0.655	0.402	
	Firm maximum	0.408	1*2	0.851	0.546	
Tekirdağ	Cumulative mean	1	1	1	0.822	17
	Firm mean	0.650	0.624	0.458	0.514	
	Firm minimum	0.365	0.244	0.116	0.149	
	Firm maximum	1*2	1.000	1*2	1*3	
Uşak	Cumulative mean	0.755	0.687	0.632	0.789	14
	Firm mean	0.506	0.421	0.392	0.297	
	Firm minimum	0.141	0.250	0.166	0.130	
	Firm maximum	1*3	1.000	1.000	0.556	
Total						461

5. Result

Efficiency structures of 484 firms in the sector coded 1711 in 38 cities in Turkey from 1998 to 2001 have been determined in this study. To put it more clearly, the analysis has been made by taking each of these firms as a decision unit and using cumulative data according to cities. The scores from cumulative data in all the cities have proved to be higher than the firm average scores. The first reason for this is that efficiency analyses are determined according to the relative structure of decision units. The presence of fewer decision units causes the deviation to decrease and the scores to be less different. The second reason is that when the data are aggregated, optimum optimal combination of factors of production is realized or an approxiamte score is obtained as close to this combination if the firms are misusing the labour or capital.

The events that lead to and are led by these results can be summarized as follows: In a structure in which specialization increases and several components of a single good are provided both from the domesitc industry and all over the world, some firms operate as a branch of other firms. This case is very obvious especially in textile industry, in which shadow/informal eceonomy is high. A firm manufactures with contract for other firms. In other words, the thread of the product is provided by the major firms while the other firms decide the quality of that product.

The quality of the firm manufacturing with contracts as the decision unit is thus lost. Since there are not costs of planning, marketing and other organizational units, the products manufactured can be sold at a lower price, which causes the efficiencies of the smaller firms to be lower. Tis is the most important of the economic reasons for the difference between the efficiency scores obtained from firm-based and cumulative data. Furthermore,

even if the efficiency level is found as low according to the results from firm-based analyses, these firms provide a significant social benefit. In the manufacturing industry the ratio of unskilled women worker/unskilled men worker is 1/3 while it is ½ in this 1711 coded sector (the ratio in Denizli is 1). This both helps the women take an active role in the economic life and prevents the unemployed from being a burden on the public sector.

It is thought that a lot of firms founded by means of the business and enterprise incitement from 1985 to 1995 should be given non-financial supports to develop marketing and organizational strategies and to use technology properly in such a way that they can increase their efficiency levels and performances. It is expected that such an investment will prove to be pretty good and beneficial for the society in the long term.

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